03 february 1998

From:

Gilbert VERNOIS
1 rue des Chalets
78140 VELIZY
FRANCE

To:

Denise Goodall Reaves
5411

Object:

Application 08/809620
(PCT/FR95/01233)

Translation of the published text -
Description and claims

FAX 3302 97440751

Recommandé AR le 02/02/98

08/809620 VERNOIS Goulven Jean Alain

PCT/FR95/01233 Translation of published PCT text WO 96/10207 (TE950916E) (TE980129)

IMPROVED TELESCOPE

FIELD OF THE INVENTION

The invention concernes the space telescopes and large membraneous mirrors.

STATE OF THE FORMER ART

H. J. Robertson (Perking-Elmer Corporation)(A symposium on support testing of large astronomical mirrors, Tucson, Arizona, 09/12/66) describes a telescope comprising a first storey with a mirror made of a multitude of elementary mirrors, a second storey containing the focal plane, and a third storey for analysing the shape of the mirror.

Perkins and Rohringer (US 4 093 351) describe membraneous mirrors tied to a concave surface stiffened by means of electric charges.

Silverberg (WO 94/10721), US priority 10/28/92, describes a membraneous mirror stiffened by surface charges, and shaped by outside fields created by a rigide support.

Le Grill (FR 2 662 512), priority 05/28/90, describes a system with a pliable membrane dependant of a rigid support which controls its shape.

Bui-Hai et Thu (US 5 182 569) envisage, for use in ultra-hight frequency, a mirror obtained by curing a rotating resin.

Drawbacks: All these rigid devices are very heavy.

SUMMARY OF THE INVENTION

Space telescope 1, with three storeys 4, 5, 6, fold able to allow its putting in orbit, comprising a membraneous mirror 45, a actuating membrane 46 for shaping mirror 45, a cylindrical enveloppe 2, or an open textile tubular frame and protecting membranes 67 (Fig 21, 27), and light source 102 (Fig 45).

Pliable cylinders closed at one end.

In an implementation (Fig 1), the enveloppe 2 of the telescope has a protecting jacket 3. They are made as cylinders closed at one end, made of composite material that can be cured under ultraviolet light or any other already known means.

Tubular frames. In other implementations (Fig 21, 27), tubular frames are made of textile tubes 41, 42, 43 of a complexe annular structure.

It is unfolded by introduction of a gaz in the tubes, then rigidified after unfolding by curing of a resin 54 situated in the annular structure of the tube, or cured by means of ultraviolet solar radiation.

Parabolic membranes. The membraneous mirror 45, the actuating membrane 46, and, in the case of a tubular frame, the protecting membranes 67, are made by spreading a liquid film 64 which hardens on the surface of a liquid 61 contained in a circular container 62 rotating around a vertical axis.

The mirror 45 and the actuating membrane 46 are tied together by means of their centrales flanges 46.4 or 46.9, either directly or by means of a cylinder 96 mounted on chamber 18.

Magnetic dipole. A magnetic dipole 141 parallel to the optical axis is rigidly tied to one of the chambers of the telescope or on its envelope.

If one electrode is implemented by a spiral shaped surface design, it works by electrostatic effect when no current flows, and by magnetic effect when a current is present.

Rotating the membranes. The membranes are infolded, stiffened, steered and stabilized by rotation.

Monitoring the parabolic shape. The monitoring of the shape of the membraneous mirror 45 is realised by a method of sagittal analysis, a derivative of the Foucault's method.

Self trained spot light telescope. In order to train a telescope used as a spot light, the lighting beam 103 has an accessary point like image confounded with the image of the observed object, and one use a Cassegrain type set-up fitted with a semi transparent parabolic secondary mirror 101, this in order to allow the light beam 51.2 to keep going towards a control device.

The invention allows, through the displacement of the optical axis 76 of the mirror 45 within the solid angle 77 which is centered on the main optical axis 39 of the telescope (Fig 13), a scanning of this solid angle 77 without moving the telescope.

BRIEF DESCRIPTION OF THE FIGURES

Fig. 1- Cut away view of telescope 1 with envelope 2 and jacket 3.

Fig. 2- Bird's eye view of the telescope.

Fig. 3- Outside view of the jacket with stiffening tubes.

Fig. 4- Cut away view of the folding by telescopic invagination.

Fig. 5- Bird's eye view of the folding by telescopic invagination.

Fig. 6- Schematic view of the folding spokes like.

Fig. 7- Bird's eye view of the folding spokes like.

Fig. 8- Bird's eye view of the scrolling of the spokes.

Fig. 9- Bird's eye view of the folded telescope.

Fig.10- Cut away view of the folded telescope.

Fig. 11, 12- Devices for the folding in a spokes like manner.

Fig. 13- Scanning of a solide angle.

Fig. 14- Gimbal mounting.

Fig. 15- Ball joint mounting.

Fig. 16- View of the ring shaped image at minimum of aberration.

Fig. 17- Image exploration by movable CCD.

Fig. 18, 19, 20- Folding of the mirror.

Fig. 21- Quadratic frame.

Fig. 22-Bird's eye view of two consecutive tubes 7.

Fig. 23- Cut away view along the optical axis and tube 7.

Fig. 24- Bird's eye view of the quadratic frame.

Fig. 26- View of an actuating electrode.

Fig. 27- Tripode frame in a plane containing optical axis and tube 7.

Fig. 28- Cut away view of a textile tube.

Fig. 29- Folding of a tube.

Fig. 30- Folding of the telescope.

Fig. 31, 32, 33, 34- Membrane on rotating liquid.

Fig. 35- View of surface designs.

Fig. 36, 37- Ring and handle for handling of the membrane.

Fig. 38- Membrane with downward flanges.

Fig. 39- Membrane with upward flanges.

Fig. 40, 41- Details of a central flange.

Fig. 42- Positioning of a central flange.

Fig. 43- Mirror and membranes for actuating and protection.

DETAILED DESCRIPTION

First embodiment: cylindrical envelope closed at one end.

The three storeys 4, 5, et 6 of telescope 1 are united by a cylindrical envelope 2 closed at one end, to which is associated a protecting jacket 3.

Envelope 2 and jacket 3 have (Fig. 31) longitudinal tubes 7, either parallel to the optical axis 39, or helicoidal 9 that can, according to the former art, be stiffened by a gaz pressure.

Insufflation of gaz will restore the original shapes of the telescope envelope and of its protective jacket.

In one special implementation, the space between the jacket and the telescope is closed by a ring 10.

Tubes 11 stiffen the openings which are maintened roughly elliptical by means of centering straps 12 and 13.

Truncated or bitruncated cylindrical envelopes closed at one end.

In a particular implementation, in order to facilitate folding, the cylindrical envelopes closed at one end are slightly truncated or bitruncated.

Vertical telescope folding. In a particular implementation of the invention, the large diameter, centered, cylinder 14 (Fig 4) is manufactured before folding either entirely or of such sufficient length as to allow partial folding.

Bottom 15 is added after the first stage of folding.

Whenever the telescope envelope 2 is concerned, the three storeys 4, 5, et 6 are tied to the jacket by their arms before folding, or during the folding (Fig. 4 and 5).

Folding by telescopic invagination. A cylindrical element 16 of cylinder placed in a vertical position is used as starting element.

This cylindrical element is maintained by external means and the part of the cylinder which is above this element is introduced inside the cylinder by folding along a circle, then push downwards until such determined height as seen fit.

In this situation, one secures the first vertical fold so obtained just above the starting cylindrical element, or slightly under, and one resumes with a new folding procedure.

In this manner, the total part of the cylinder above the starting cylindrical element 16 finds itself folded within the height of this starting cylindrical element 16, or slightly greater height, this in order to create, with the starting element a cylindrical torus with a thickness roughly equal to the sum of the thickness of all the different folds.

The same procedure takes place with the bottom part of bitruncated cylinder of the telescope envelope.

One therefore has a stack of all three telescope storeys and elementary folding 17 of the bevelled sun shade.

The mirror storey chamber 18 is stretched downwards by a centered mast 21 allowing communications between the telescope and the outside, this mast carrying solar panels, reactive means of positioning and telecommunication means, not shown.

Folding telescope in a spokes like manner. (Fig 6, 7, 8) According the former art, each stage of the telescope is made of a central chamber tied, by three or four arms 23 (Fig. 2 and 4) to a cylinder 2 closed at one end.

The vertical folding by invagination having be achieved, the three chambers are stacked. The nine or twelve arms 23 are stacked as well, three by three.

Folding telescope in a spokes like manner, according to the invention, is then implemented with a number of spokes multiple of

scrolling is done at the contact surface, around the telescope scroll.

The bottom of the jacket has a hole allowing the external mast 21 to go through it.

Crumpled folding of the bottom (Fig. 10). During the spokes folding, the bottom of the cylinder closed at one end remains always in the inside of a perimeter determined by the spoke folds. Under these conditions, the bottom 30 of the envelope, or 22 of the jacket, take a natural or assisted folding which is difficult to draw, and which is contained within a restricted space showed by waves 31 (Fig. 10).

Unfolding vertical telescope tubes (Fig. 4, 5). Unfolding vertical tubes 32 and 33 are closed tubes set up symmetrically around the close at one end cylinders 2 and 3, along a generating line.

They are made integral with cylinders closed at one end 2 and 3 at heights identical to those of the cylindrical elements of the telescopic folding, thanks to braces 34 and 35 (Fig 4, 5).

They are folded by telescopic vertical invagination, in the same way as the cylinders 2 and 3, in cylindrical elements of same height as that of the cylinder closed at one end and at the same time.

Insufflating in these infolding tubes, through openings 36 and 37, of a pressurized gaz, causes their expansion and that of the blind cylinders.

They are part of the final stiffness of the blind cylinders.

Folding means. In one example of implementation (Fig. 11, 12), the internal 24 and external 25 folding means are made of movable trolleys 26 and 27 guided radially in an horizontal plane, by guides 38, and fitted with linear devices 24 and 25 perpendicular to this plane and able to take a lower or higher position.

In one particular implementation, the vertical elements are made of two or more vertical sub elements capable of relative closing motion while staying parallel to each other.

In this manner, the motion devices can grad between their vertical components the concentric fold created by the vertical folding.

Second implementation: tubular frame. The telescope 1 (Fig. 21),

with optical axis 39, has three storeys 4, 5, and 6, and has a frame 40 made of many main tubes 41, parallel and having the same length, each being divided into two portions linked to storeys 4, 5, and 6 of the telescope by parallel spacing tubes 42.

Storeys 5 is at about equal distance from storeys 4 and 6.

To these first tubes are added (Fig. 22) reinforcing tubes 43 linking elements of flexible junctions 44 of former tubes in the planes defined by the main tubes 41 taken two at a time.

Elements of junction 44 allow the continuity of the internal space of the tubes.

Mirror 45 and actuating membrane 46.1 are shown in a cut away including the optical axis and a tube 41, but limited to the optical axis (Fig. 24).

Active elements of the telescope are united in chambers 18, 19, and 20 located in the center of the three storeys 4, 5, and 6, and held at those centers by tubular arms, set in a star 23, and tied to tubes 41 (Fig. 24).

Theses arms 23 (Fig. 25), are made of at least two tubes 23.1 and 23.2 located in the planes containing the optical axis and one tube 41, tube 23.1 being above tube 23.2.

These tubes 23.1 and 23.2 are united at one of their ends to joints 44 located at ends of tubes 41, and at their other ends to devices 23.3, as per former art, of variable length, located on or inside the chamber 18, 19, and 20 and allowing, if necessary, chambers 18, 19, and 20 to be adjusted onto the optical axis 39 of the telescope.

Electrodes or coils 23.4 are drawn on tubes 23.1 or 23.2 (Fig. 26) so as to adjust the perpendicularity between optical axis and actuating membrane, and therefore, between optical axis and mirror.

In this implementation, the mirror and its actuating and protecting membranes are inside the frame.

In a particular implementation (Fig. 27), frame tubes 41 are not parallel anymore, but generate a tripod pyramidal mast.

The triangular base of the tripod mast is contained within a circle which diameter is much less than the one of the mirror 45

and its actuating and protecting membranes, the latest being outside of the mast.

Flexibles tubes: Frame tubes are made of flexible identical textile tubes with complex annular structure (Fig. 30).

The outside textile envelope 48 of the tube is covered with a black dull film 49 chosen for its absorbing capacity within the solar visible spectre and preferably of a conducting nature.

The annular zone 50, contained within the previous, and heat isolating, is made of multiple layers which alternate open pores elastic foam and reflecting film.

One sealed textile tube 51 separates insulating zone 50 from the following active zone 52 made of textile fiber 53 coated with liquid resin 54 which hardens under heat.

Some of these fibers 53 are distributed evenly in layers parallel to the axis of the tube in such a way to determine precisely the length of one element of the tube.

A flexible sealed textile tube 55 isolates active zone 52 from the free inside 56 of the tube.

On this textile tube 55, a coating 57 is deposited which, in the presence of a given gaz induces an exothermic reaction.

A film 59, porous to the chosen gaz, prevents sticking of the coating onto itself during folding.

In order to unfold and stiffen, one introduces, inside the folded and flattened tube, a pressurized gaz 58 which can be the gaz that reacts with the coating.

The exothermic reaction, for instance a slow oxydation in the presence of oxygen, rise the temperature, and this increased temperature initiate the curing of the resin 54 which coated the fibers 53, and in so doing insures the stiffness of the unfolded tube.

In a first alternate way, there is no reactive coating 57 nor any protective film 59; the exothermic reaction is the result of two reactive gaz 58 and 60 introduced simultaneously or sequentially in the tube.

In a second alternate way, there is no coating 57 nor film 59; the resin 54 is cured under the effect of a gaz, and the textile tube

containing the resin 54 is porous for this gaz.

Folding of the frame. The zigzag folding is made by folding at regular intervals the flattened tube over itself (Fig. 29a, 29b). The different tubes are then laid over, folded (Fig. 30) and their ends tied to the elements 44 joining the tubes together and to the elements 23.3 joining the tubes to the chambers.

Mirror and actuating or protective membranes.

First preferred implementation (Fig. 31).

On takes a liquid 61 in an horizontal container 62 rotating smoothly around a vertical axis. Then, a small amount of another liquid 64 is poured over it all the way to the edge 63 of container 62.

This new liquid will wet the edge 63 and will solidify by spontaneous or induced curing thereby creating a membrane 46.

Second preferred implementation. It differs from the one before in that the liquid 64 contains a dissolved product which, after evaporation of the liquid 64, will leave a film onto the underlying liquid.

In a variant case, liquid 64 also contains suspended fibers.

Third preferred implementation (Fig. 32). In this case, the liquid 64 only contains suspended fibers which, after evaporation, will create a fibrous layer susceptible to receive a resin that can be cured.

A smoothing layer is superimposed on the composite layer so that the roughness of this composite layer does not showing at the surface of the smoothing layer, or be smaller as a pre set value.

Fourth preferred implementation. It differs from the first in that the liquid 64 is obtained by simultaneous or consecutive addition of two different liquids.

Fifth preferred implementation (Fig. 34). Liquid 64 is absent, and the membrane 46 is created by a liquid or a gaz that solidifies directly onto the surface of the main liquid 61.

Sixth preferred implementation (Fig. 33).The surface of the main liquid 61 is first covered with a film 66 that became an intermediary membrane 66 onto which the liquid 64 is added or on which are brought one or several products that immediately harden

to create membrane 46.

Reflecting layer: A reflecting medium is put on the membrane while it is still on the rotating liquid 61, namely by the stacking layers having appropriate dielectric indices and appropriate thicknesses.

Surface designs: While it is still on main liquid 61, the membrane 46 is locally covered, by means in accordance with the former art, with a conducting covering in the shape of the surface designs 46.1, in so doing creating a number of annular electrodes centered on the optical axis, acting upon the radius of curvature, and a number of local electrodes 46.2 acting upon local defects.

Electronic spread in the membrane. The membrane 46, while still on liquid 61, is locally covered, by means of the former art, with a thin structure identical to that of an integrated multilayer circuit having conducting, insulating or semi conducting elements, contiguous or superimposed.

Electrical supply of these surfaces designs is provided by surface conductors 46.2 linked to a power supply through the center of the membrane.

These surface designs IC, when integrated to the actuating membrane of the mirror, allows, according to the invention, through the use of a capacitive coupling between the membrane and the mirror, a self control of the distance between mirror and membrane, and consequently the stabilization of the shape of the membranes without the intervention of the central system.

Protecting membrane (Fig. 27, 43). According to the invention, in the case of a tubular frame, one or several parabolic membranes 67 and 67.1, having flanges 65.8 raised above mirror 45, are located behind actuating membrane 46.

According to the invention, these membranes are made of a fibrous structure impregnated with resin, the fiber being preferentially oriented parallel to the surface of the membrane.

Membranes 68 and 69, located at the focal point and at the sagittal analyser, protect these points from direct star light. A very narrow band filter 70 (Fig. 50) protects equally the monochromatic sagittal analyser from stray light.

Actuating coils. Envelope 2 of telescope 1 is fitted at its bottom, at the level of the mirror, with a coil 71 made of conducting elements 72 encircling said envelope 2 (Fig. 1). The coil so created generates, when activated by an electric current, a magnetic field parallel to the axis of the telescope. The discrete coil 73 of the actuating membrane will interact with this magnetic field, so as to maintain the desired shape of said membrane and to keep it centered on the optical axis of the telescope.

In a particular implementation, the membrane fitted with discrete coils is metallized and constitutes the mirror of the telescope. The membrane 65 fitted with coils 73 has only an approximate shape, and the final shape is given to the mirror membrane 45, its shape being determined by the electrostatic forces existing between the conducting surface 74 of the mirror membrane and electrodes 75 present on membrane 65 which has an approximate shape and is used as actuating membrane.

Mirror control. Surface electronic circuits integrated to the membrane during manufacturing, control the potentials of the electrodes acting upon the mirror, as well as the magnetic field of the membrane coils and the magnetic field of the telescope. The metallised surface 74 of the mirror 45, or any conducting surface, should the reflective surface be dielectric, will initially be at 0 potential.

Electrodes 75 of actuating membrane 46 are set at positive or negative potentials, and as a result, decrease or increase the relative distance between mirror and actuating membrane.

In this manner, important local distorsion of the actuating membrane 46 will not prevent getting a perfect shape for the mirror.

Surface IC receive their instructions from control electronics which themselves get their information from the sagittal analysing device.

Macro and micro controls. The system, according to claim, separates long range action acting on the actuating membrane through magnetic fields interacting with the field of the coil,

and short range action acting through electric field between membranes.

Field scanning (Fig. 13). This dual system allows an important movement of the mirror 45 so that the optical axis 76 of the mirror will be able to scan a solid angle 77, while keeping the quality of the image at the focal plane 78 of the telescope.

This solide angle 77 is determined by the limits of the passible magnetic and electrostatic actions, in conjunction with the mechanical characteristics of the membranes, of the energy available and of the values of the voltage of the power supplies.

Mobile sagittal analyser (Fig. 13). The sagittal analyser, or any mirror control device located at the level of the sagittal segment, moves, according to the invention, within a circle centered on the optical axis 39 of the telescope, while staying pointed toward the intersection of the ideal extended surface of the mirror 45 and said initial optical axis 39.

When in a new position, away from the initial optical axis, the sagittal analyser 79 sends to the mirror electronic control device the informations necessary to give to the mirror membrane its parabolic shape, or any other shape required for a minimum of aberrations, having their sagittal segment determined by the position of said sagittal analyser 79.

This mirror 45 will generate on the photoelectric reception matrice 80 the image 81 of objects located in a direction deviating from previous optical axis 39 at double the angle of the deviation of the optical axis of the mirror 45 as materialized by the sagittal analyser 79.

In order to compensate for loss of quality of the image 48 when far for the optical axis, the shape of the mirror 45 is optimized by the sagittal analyser 79 itself, associated or not to a control device located in the focal plane 79, 78.

Gimbal mounting (Fig. 14). In order to point the mirror 4, the cylinder 82 centering the mirror 45, possibly by an intermediate motor ring 83, and its membrane 46, is free to turn inside a solid angle.

In a particular implementation, this cylinder 82 is gimbal mounted

along diameter 84 and 85 and actuators 86 point the axis of the cylinder towards the sagittal analyser.

In another implementation (Fig. 15), the mirror and membrane centering cylinder 49 is centered on ball joint 87.

Annular scanning (Fig. 16).In one particular implementation, the sagittal analyser remains centered on the principal optical axis 39 of the telescope.

The mirror generating line is progressively modified while preserving the mirror circular symmetry.

This distorsion is such that the image 81 has a minimal aberration centered ring 88 which increase radially on the receiving photoelectric matrice 80, like a circular wave, in conjunction with changes of the mirror.

This receiving matrice 80 is scanned synchronously with the scanning of ring 88, the latest being the image with the minimum of aberration.

In this manner, the field of least aberration image can be greatly expanded.

In one particular implementation, one or several photoelectric receiving matrice 89 are moved in a circular or helicoidal fashion and scan the least aberration ring 88, thereby allowing scanning of a large area with photoelectric matrices of small area.

Mirror and membrane folding (Fig. 18, 19). The mirror 45 and the actuating membrane 46 are made totally or in part of a material with shape memory.

After manufacturing, the mirror 45 and the membrane 46 are distorted in such a way that this distorsion is retained until new conditions appear, that brings back the initial shape.

The membranes are concave; if one pushes (Fig. 18) the bottom of the concavity, at its center and perpendicularly to the tangent plane, it results a symmetrical circular distorsion which will intrude into the concavity.

Examination of this previously concave surface then reveals a concave peripheral ring and a central convex surface.

This central convex surface is equally pushed in the same conditions as before, and a new element of concave centered

surface can be seen.

Pursuing with the creation of alternately concave and convex surfaces, one obtains a surface resembling a series of circular, centered waves (Fig. 18, 19, and 20).

The thickness of this folding can be small as one wishes. It only requires an increase in the number of waves.

Once these waves fixed according to proper physical conditions, the almost flat object so obtained can be first scrolled lengthwise and then rolled in a circle.

Windings for rotating field. In order to allow, in conjunction with the annular motor ring 83, the rotation of the mirror, several windings are located on the blind cylinder 2, at the level of the mirror storey.

Powering these windings with the correct phases induces a rotating field that rotates the mirror.

Rotating container.

First preferred implementation (Fig. 16 and 17). The edge 63 of a circular rotating container 62 is surmounted and in contact with a ring 90 having handling means 40, such as handles allowing this ring to be grabbed and taken away from the edge.

The membrane 46 created when the film 64 solidifies, will stick the ring 90 thereby allowing this handling.

Second preferred implementation (Fig. 18). The outside wall 92 of the container is a surface of revolution.

The membrane 46 extends, by means of former art, with equal or greater thickness, on the outside wall 92 of the container, previously coated with a non sticking product, and in so doing creating a peripherical flange 4.3 that increases the stiffness of this periphery, thereby allowing it to recover better and faster its original shape.

It ends with a thicker band allowing handling.

In a variation (Fig. 19), the membrane extends on the inside wall of the container in the shape of a flange 46.8 higher than the rotating liquid.

Third preferred implementation (Fig. 19). The container 62 has a central circular hole 93 limited by a wall 94 holding the liquid.

The external surface 95 of wall 94 (facing the axis) has the shape of a cylindrical or conical surface of revolution.

The membrane 46 is extended, with increased thickness, on the external surface 95, in so doing creating an annular central flange 46.4.

This annular flange 46.4 is fitted with a cylindrical thick part 46.5, and next, vertical divided thin strips 46.6 joined together in a terminal ring 46.13. (Fig. 20)

This terminal ring 46.13 owns the physical junction of the membrane and a cylinder 96 centered on optical axis 39.

These vertical strips increase the pliability of the bottom of the flange 46.4.

Should the membrane be an actuating membrane, these vertical bands 46.7 will be conducting and will connect at one end with the surface designs 46.1 of the actuating membrane, and at the other end with the electronic central control device by means of cylinder 96.

Fourth preferred implementation. In a variation, the membrane is extended, by a flange 46.9, in the inside surface of the wall of the container and therefore raised above the rotating liquid.

In another variation (Fig 41), the membrane extended on the inside surface of the wall of the container, goes down, along this wall, in the central opening, creating a double flange 46.10.

Centering of the membranes. Conductive strips 46.8, and conductive rings 46.12 of axial placing regularly located, are deposited on the cylindrical part 46.5 of the flange 46.4, or of the flange 46.10 or 46.11, and shall serve of electrodes to center the membrane 46 on a vertical cylinder 96 centered on optical axis of the telescope 1, and made integral with container 18.

This vertical cylinder whose diameter is lower than flanges diameter, is fitted with electrodes 96.1 and 96.2 located to control the location of the flange 46.4 and therefore, of the membrane.

In particular, according to the invention, rings 96.1 perpendicular to the cylinder axis, shall have a constant interval, different of the spacing of equivalent rings 46.12 of

the flange, in order to equalize the gap between a number a of rings of the cylinder and the gap between a number a-1 rings of the flange.

In this manner, flange 46.4 can be displaced along cylinder 96, playing on the potentials of the different rings.

Should the membrane be a mirror, the conductive strips 46.7 will conduct superficial charge to the mirror.

Two examples of arrangement (fig. 43) show parallel membranes and back to back membranes.

Willful distorsion of the rotating liquid. In order to obtain an exact parabolic shape for the working membrane, or any other shapes close to it, one must correct the shape of the rotating liquid in view of the various possible distorsions.

According to the invention, this compensation is achieved by electrostatic forces acting upon the surface of the rotating liquid.

Rotating container (Fig . 44). The generating line of the bottom 97 of the circular container 62 containing the liquid under rotation should preferably be parabolic.

First preferred embodiment.

An intermediate insulating film 98 is deposited on the surface of rotating liquid 61.

A conductive layer 98.1 is then deposited on this film 98.

Charges of same sign are brought on the superficial conductive film 98.1, and on central electrode 99 centred on axis of rotation of the rotating liquid and on top.

The membrane 46 is then deposited on the conductive film 98.1.

Intermediate film 98 should be eliminated when the membrane should be separated from main liquid 61.

Electrode 99 shall be preferably a plurality of electrodes 99.1, with annular shape, centered on axis of rotation, and having radius such that the association of the size of different radius and of the applied charges to these electrodes, produce a verified correction of shape.

Measures effected for several diameters by mechanical means, or optical means operating at the sagittal segment, or in a plane

near the surface, and measures of the champ existing near the surface, are effected to pilot charges brought to the electrodes.

Second preferred embodiment.

The intermediate film 98 does not necessary if the liquid 64, or the membrane 46 are conductive.

A conductive film 98.1 is necessary if the liquid 64 or the membrane 46 are insulating.

The electrodes 99 and 99.1 are replaced or doubled by an electrode 100, or electrodes 100.1 located under container 62, rotating or not with this container 62, and setting at selected potentials.

The effect of these electrodes will multiplyied by the dielectric constante of the recopient bottom that contain ferroelectric substances.

Third preferred embodiment. The shape correction is achieved after manufacturing of the membrane.

A conducting thermosensitive membrane 46 is laid on rotating liquid 61, after application of a corrective field, and elevation of the temperature, so as to have a small change of shape.

It will take the corrected shape and keep it after cooling.

Fourth preferred embodiment. A insulating membrane 46, constituted without correction of shape on a conductive film 96, is submitted, after installing a correcting field, to a rise of temperature allowing to put it out of shape to follow the exact new shape, that it shall retain after the return to the starting temperature.

Self pointed spot light telescope (Fig 45, 46). A secondary parabolic mirror 101, semi transparent according to the invention, is set in a Cassegrain type mounting.

A laser 102 located at the top of the main mirror, or recessed, sends a beam 103 having the same diameter as the secondary mirror 101.

Part of this beam 103.1 will be reflected towards and will constitute the beam emitted by the telescope.

The transmitted portion shall be focused, after complete crossing the dioptric device 104 (onto which is the secondary mirror), and after crossing plan containing the CCD matrix 105 receiving the image, and curl back, in a beam 103.2, on a tertiary parabolic

mirror 106 which shall form a point image 103.3 on the back of this image receipt matrix 105.

Should this matrix be sufficiently transparent, it will be sensitized by this point like image; and if not, a second matrix 105.1 will be installed on its back.

Secondary mirror (Fig 46). A portion of the light rays 107 issued by the object 108 under scrutiny, after having be reflected by the main mirror 45, cross the secondary semi transparent mirror 101 and the parallel surface 110 of the diopter 104 which carries mirror 101.

In a such way, the convergent beam is not much distorded, particularly the rays of this beam constituting the center of the image, and the image of the object under scrutiny at the focal plane, on the receiving matrix.

This matrix sees at the same time the point representing beam and the image of the object under scrutiny.

A servo control of the direction of the telescope then allows the image of the object under scrutiny and the laser reference point to coincide, and therefore allows the beam to be directed towards the object.

Centering of the laser beam. If the axis of the initial laser beam 103 is not parallel to the axis of the third mirror 106, its point like image 103.3 given by the third mirror 106 is shifted away from its theoretical point on the matrix; a servo-control of former art will bring it back there.

Materialising of the optical axis. Chambers 19 and 20 or chambers 18 and 19, or even elements of these chambers are made parallel by interferential means according the former art, while maintaining their spacing constant.

Centering of the optical axis.

First preferred implementation (Fig 47). A spherical mirror 112, possibly annular, is made part of chamber 19 or 20. This mirror 112 is, according to the invention, tied to the back of third mirror 106 or, better, is an integral part of it.

The optical axis of this mirror defines, a priori, the optical axis 39 of the telescope.

The curvature center 112.1 of this mirror is located at the level of the other chamber.
If a light source 113 is placed close to the center of curvature of this mirror, the later will generate an image 114 without aberration.
If the light source is on the optical axis of mirror 112, the image is also on that axis.
According to the invention (Fig 47), the light source 113 situated on the optical axis, is the image given by a flat mirror semi-transparent 115, of a real point like source 116, which is preferably monochromatic.
This point like source 116 is a thin annular hole, made in a opaque screen, strongly lighted .
The image 114 is made of a central spot surrounded by diffracting rings.
According to the invention, an image detection device 117 with extended capacity in grey levels, preferencialy a CCD matrix with extended capacity in grey level, is located at the level of image 114 and perpendicularly to the optical axis.
This CCD matrix 117 can be plane, but, according to the invention, it is spherical, and adjusted on the curvature center.
According to another implementation, it can equally will be constituted of two or three strips 117.1 or 117.2 symmetrically centered on the optical axis.
If, as a result of a relatif movement of the two chambers, the image 114 of the source 113 is not anymore centered on the optical axis of the mirror, the matrix 117 will monitor a new centering.
To that effect, the matrix analyse the image 114 and finds the center of the central spot and of the diffraction rings.
It then puts the center on the optical axis, according means of the former art.
Second preferred implementation. Two or three devices of the first implementation, set symmetrically around the optical axis, clear the region of this optical axis.
This set-up is used to interlock chamber 18 and 19, or elements of these chambers.

Lighting a target outside of the optical axis. In order to light a target outside the optical axis, it is enough to make the spot beam, going out of the main mirror, parallel to the incoming beam. This is obtain by a modification of the laser beam 50.

Then, the point-like image 103.3 of beam 103.2 on matrix 105 or on semi-transparent matrix 105 at the focal plane, is off center.

To bring the beam on the target, it is therefore enough to put the point like image 103.3 on a symmetrical point of the image 108.1 of the target 108.

Stray lights. Should the observed object not be very bright, it will be located classicly by two or three stars.

In this fashion, if the light diffused by the laser beam while crossing the various media is enough to blot out the targeted object, these stars, being much more luminous, will insure the correct pointing.

Interferential filter.

First preferred implementation. According to the invention (Fig 46), a detachable interferential filter 118, possibly having the shape of a portion of a sphere, protect the front end of the image receiving matrix 105 from the monochromatic laser beam 103.

Second preferred implementation. An interferential filter, possibly having the shape of a portion of a sphere, protects the receiving matrix from stray light emanating from the sagittal analyser.

Choosing a monochromatic sagittal analyser source having the same wave length as the laser, will enable the same interferential filter to protect the matrix from stray light coming from the laser.

Third preferred implementation. Inserting an interferential filter transmitting only the received wave length, allows to do away with filtering the stray light coming from the sagittal analyser.

Mask mirror. The center of the semi-reflecting mirror 101 is totally reflecting on the same surface as matrix 105.

In this manner the laser beam 103 will not reach the image receiving matrix 105.

Sagittal analyser. For each particular curve of revolution there

exists a biunivocal relation between a point 120, or 120.1 of the sagittal segment 119 and the radius 121, or 121.1 of a centered ring of the surface of revolution.

If one knows the relation supposed to exist between the radius 121 and point 120, one can modify the surface under investigation in order that it satisfies this relation (Fig 49, 50).

Light source of sagittal analyser. To avoid a defect of revolution of the mirror, the light source 122 must be on the optical axis 39.1 of the mirror (Fig 47).

It cannot be physically on this axis since this axis is on the sagittal segment that must be examined.

According to the invention, a semi-transparent mirror 123 generates the virtual image 124 of the source 122 on the optical axis, a location chosen to be the bottom of the sagittal segment 120.

In this manner, this light source can be more easily be complex.

It will be, according to the invention, the point like image of a monochromatic laser beam 125 as generated by the semi-transparent mirror 123.

Acquisition of the image (Fig 48). As soon as the mirror 45 is stiffened by electrostatic charges and by rotation, it generates a blob-image 126 of source 72 of the sagittal analyser, image centered on its optical axis 39.1.

This image can be very far from the teoretical axis 39 of the telescope, and consequently very far from the sagittal analyser.

Auxiliary screen. According to the invention, a large size auxiliary screen 127, perpendicular to the optical axis 39 is situated beyond the sagittal analyser (Fig 48), or on this side but in that case with a central aperture having the side of the sagittal analyser. The non pinpoint image 126 of the sagittal analyser source 124 appears on screen 127.

An electronic camera examines this screen and take hold image 126 of source 124.

The electronic control device of the mirror 45 brings this image at the center of screen 127 where the sagittal analyser stands.

This sagittal analyser centers image 126 on its own center,

located on the desired optical axis 39.

Control principle. This sagittal analyser is made (Fig 50), according to the invention, of a photoeletric matrix 128 and a screen 129 scanning the sagittal segment 119 of the mirror 45. This opaque screen 129, perpendicular to the optical axis 39, and with hole 131 centered on this axis at a particular point 120 of the sagittal segment 119, intercepts the conical sheets that do not pass through point 120 and does not intercept the conical sheet which passes through this point 120 of the sagittal segment. This conical sheet leans upon a ring of radius 121 of mirror 4, and trace a ring of radius 130 on the photoelectric matrix 128.

The radius 130 of this ring is proportional to the corresponding radius 121 of the mirror 45 being scrutinized.

When hole 131 explores the sagittal segment 119, the ring of radius 130 goes over photoelectric matrix 128.

One can establish a particular correspondance between points 120 of the sagittal segment and the radius of the corresponding rings.

Image examining matrix.

First preferred implementation. According to the invention, the photoelectric matrix 128, with extended capacity in levels of grey, perpendicular to optical axis 39 and centered on this axis, is located at some distance from the sagittal segment 119, going away from the mirror.

According to the invention, the photoelectric matrix is a portion of sphere centered on the middle of the sagittal segment.

Second preferred implementation. According to the invention, the matrix can be reduced to a number of matricial segments centered on the optical axis and equally distributed around this axis.

Sagittal analyser screen.

First preferred implementation (Fig 50). The screen 129 is, according to the invention, a photoelectric matrix whose central pixel is replaced by a hole 131.

This matrix 129 is capable of a movement parallel to the optical axis 39, in so doing enabling hole 131 to explore the desired sagittal segment 119.

The avantage of a photoelectric matrix over the screen stands in

the fact that the matrix can center the spot image 126 on the active area, from the start of control of mirror 57, and can re center again after any operating incident.

Second preferred implementation (Fig 51). The mobile screen 129 is replaced by a stack of polarizing cells 129.1, particularly liquid crystals, having an inactive central portion 131.1.

These cells can simulate a flat screen having a hole 131 on the optical axis 39 and moving perpendicularly to its plane.

In a particular implementation, the polarizer is unique and the polarizing screens are made of crossed analysers.

Third preferred implementation. The central portion of mirror 45 is not used.

The mirror examining matrix 128 has a central aperture through which pass a cylinder 132 at the end of which is a photoelectric matrix 133 centered on the optical axis 39.

The cylinder can move along the optical axis and can therefore explore the sagittal segment 119.

When the spot image 126 is brought on matrix 128, this latest centers it on the matrix which them centers the sagittal segment.

Independent rotation of the membranes. According to the invention, the membranes have a rotationnal movement independent of that of the telescope.

This rotation is actuated, according to the invention, by the rotation of the cylinder 96.

Earth bound telescope (Fig 54). It has three storeys 4, 5, 6, the chambers 18, 19, 20, the sagittal analyser, the membraneous mirror and the emitting laser.

The three chambers are made integral by optical means.

The frame is that of the first preferred implementation with 4 or 6 tubes 41.

Former art atmospheric turbulence compensating devices will cooperate with the sagittal analyser to give the best possible image.

To put the mirror outside of atmospheric movements there will be, inside the frame, a air tight cylindrical jacket 134 the diameter of which is slightly greater to that of the mirror, and which can

be fed with slight over pressure (Fig 54).

This jacket is made of sound proofing material, chiefly by alternating structural materials of various densities.

The upper portion of this jacket is closed by a transparent membrane 135, perpendicular to the optical axis.

This membrane is tied to a rigid ring 136 situated on the top of the jacket.

It is placed just under the stage 5 containing the focal point.

A flange 137, extending the jacket over a certain height protects this membrane from stray lights.

An over pressure is created within the jacket so that membrane 135 takes a convex shape.

This jacket is linked to a mechanical orienting system, not shown, independent of the system orientating the mirror, so that the wind gusts which have a considerable effect on its great area cannot have any effect on the mirror or on the frame.

Floating mirror. According to the invention, the membraneous mirror 45 has a parabolic shape and floats or is semi floating.

It has a flange 46.3 which covers, while leaving a small space, a rigid support 138 receiving the actuating membrane 46 of the astronomical telescope.

It also has a flange 46.4 intruding into the central hole 139 of the rigid circular support 138.

These flanges allow the periphery and the central portion of the mirror to be centered, and also allow its central electrical connection.

Rigid circular support. (figures 55 and 56)

First preferred implementation. The rigid circular support is fitted with surface electrodes 46.1 which allow control of the shape of the mirror under the control of the sagittal analyser of chamber 20.

According to the invention, this rigid circular support supports, (figure 55), a parabolic membrane 46 slightly stretched by a small under pressure, in such a manner as not to alter its initial parabolic shape.

Active annular cover 139 and 140, fitted with surface devices

facing the mirror 45, help in controlling the edge and the central portion of this mirror.

Second preferred implementation.

This rigid circular support (figure 56) has a concave parabolic surface, onto said surface are surface devices 46.1 actuating the mirror 45.

To increase the efficacy of this control, there is a ferroelectric layer in the surface.

Space telescope with detachable mirror storey (Fig 52, 53). In a particular embodiment, the telescope 1 is made of two separated elements reunited in space after installation of the mirror and the actuating membrane in mirror storey 4.

Envelope 2 and jacket 3 are each made of two separate elements which can be associated:

a) the upper cylindrical open element comprising focal plane storey 5 and storey 6 containing the centre of curvature,

b) the lower cylindrical closed element comprising mirror storey 4.

A linking device allows the reunion of these two elements.

Integrated inflatable circular tubes 8, and envelope-jacket linking rings 10 maintain the circular shape of the bottom of the upper element and the top of the lower element.